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Author(s): Anthony A. Braga

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Serious Youth Gun Offenders and the Epidemic of Youth Violence in Boston

Anthony A. Braga¹

Boston, like many other major cities, experienced a sudden increase in youth homicides during the late 1980s and early 1990s. Research evidence suggests that the recent epidemic of urban youth violence was intensely concentrated among criminally active young black males residing in disadvantaged urban neighborhoods rather than all young black males residing in disadvantaged black neighborhoods. Other researchers, however, suggest that there was a diffusion of guns and gun violence from youth involved in street crack markets to youth outside the drug trade who armed themselves primarily for self-protection against the armed criminally active youth. In this paper, criminal history data are analyzed to determine whether the criminal profile of Boston arrested youth gun offenders changed over time and micro-level data on youth gun assault incidents in Boston are examined to unravel whether there were noteworthy changes in the nature of these violent events over time. The results of these analyses suggest that the youth violence epidemic in Boston was highly concentrated among serious youth gun offenders rather than a diffusion of guns away from the street drug trade, gangs, and criminally active youth.

KEY WORDS: youth violence; epidemic; guns; gangs; diffusion.

1. INTRODUCTION

Although overall homicide rates in the United States declined between the 1980s and 1990s, youth homicide rates, particularly incidents involving firearms, increased dramatically. Between 1984 and 1994, juvenile (younger than 18) homicide victimizations committed with handguns increased by 418%, and juvenile homicide victimizations committed with other guns increased 125% (Fox, 1996). During this time period, adolescents (ages 14–17) as a group had the largest proportional increase in homicide commission and victimization, but young adults (ages 18–24) had the largest absolute

¹Program in Criminal Justice Policy and Management, John F. Kennedy School of Government, Harvard University, 79 John F. Kennedy Street, Cambridge, MA 02138. Voice: (617) 495-5188 E-mail: Anthony_Braga@harvard.edu

increase in numbers, and there was a good deal of crossfire between the two age groups (Cook and Laub, 1998). All of the increase in youth homicide was in gun homicides (Cook and Laub, 1998). For many cities, the bulk of this dramatic increase in youth homicide occurred in the late 1980s and early 1990s. In Boston, youth homicide (ages 24 and under) increased more than threefold—from 22 victims in 1987 to 73 victims in 1990 (see Fig. 1). Youth homicide remained high even after the peak of the epidemic. Boston averaged about 44 youth homicides per year between 1991 and 1995.

Like many other major cities, Boston experienced a sudden downturn in youth homicides during the latter part of the 1990s. The number of Boston youth homicides decreased to 26 in 1996, and further dropped to 15 youth homicides in 1997. The low level of youth homicides continued through 1998 (18 victims), 1999 (15 victims), and 2000 (18 victims). An interagency problem-oriented policing intervention, which tightly focused criminal justice attention on a small number of chronically offending gang-involved youth, was associated with the significant reduction in youth homicide and non-fatal gun violence (Braga *et al.*, 2001). The implementation and impact of this intervention has been extensively documented elsewhere (see, e.g., Kennedy *et al.*, 1996; Kennedy *et al.*, 2001). This paper does not examine the downturn in youth homicide in Boston. Rather, it examines the importance of serious youth offenders in the sudden upswing of youth violence in Boston between 1984 and 1995.

To some observers, the recent epidemic of youth violence resembled a “flood in a canyon” as it was intensely concentrated in a particular demo-

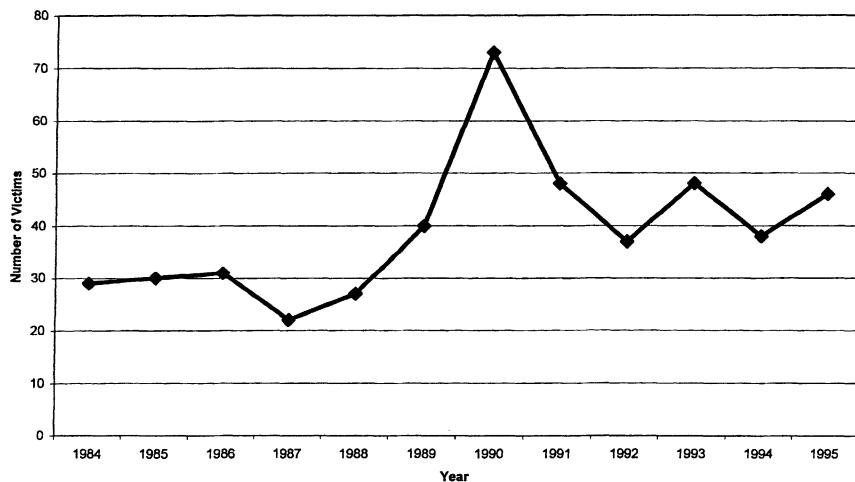


Fig. 1. Youth homicide in Boston ages 24 and under, 1984–1995.

graphic group—black males under age 25 residing in disadvantaged urban neighborhoods (Cook, 1998; Cook and Laub, 2002). The involvement of armed youth in street crack-cocaine markets and street gangs has been nominated as important dimensions of the epidemic (see, e.g., Reiss and Roth, 1993). This suggests that the epidemic was narrowly channeled among criminally active youth rather than all youth residing in disadvantaged black neighborhoods. Blumstein (1995), however, suggests that there was an indirect diffusion of guns from youth involved in street crack markets to youth outside the drug trade who armed themselves primarily for self-protection against the armed criminally active youth. In turn, the presence of firearms in the hands of these other young people transformed the settling of ordinary disputes from the use of physical force to shootings. The diffusion hypothesis presents a very different image of the trajectory of the youth violence epidemic relative to the intensification, or “flood in the canyon,” perspective.

This paper assesses the extent to which youth violence was concentrated among criminally active offenders by examining the criminal profile of youth arrested for gun crimes over the course of Boston’s youth violence epidemic. Section 2 briefly summarizes the existing literature on the youth violence epidemic and describes the relevant dimensions of Boston’s youth violence epidemic. Sections 3 and 4 describe the data collection methodology, detail the statistical models used to analyze the data, and present the results of the quantitative analyses. The conclusions drawn from the research findings are discussed in Section 5.

2. THE EPIDEMIC OF YOUTH VIOLENCE

2.1. Key Elements of the Youth Violence Epidemic

Although the direct causes of the youth violence epidemic remain somewhat elusive, a concrete story emerged that seems to fit with experience and research evidence. Moore and Tonry’s (1998) synthesis of key events provides a useful framework and is quickly summarized here. In the late seventies and early eighties, changes in structural factors produced conditions in inner-city minority communities that were ripe for an epidemic. The social and economic structure of many urban neighborhoods collapsed under a variety of social and economic pressures. Employment opportunities disappeared and small businesses moved away from the inner city. Under these economic pressures, families broke apart and children grew up under increasingly adverse conditions. In response to these conditions, some youth joined gangs in search of affiliation and security. Gangs produced fear and rivalries and caused other gangs to form and more youth to join gangs.

An epidemic of crack cocaine hit these troubled communities during the mid to late eighties. Some existing youth gangs and other youth not involved in gangs participated in street-level drug markets and armed themselves with guns to protect themselves and resolve business disputes. The arming of youth participating in street drug sales produced both dangerous conditions on the street and a cultural style that encouraged other youth to acquire guns in response. A large supply of available guns made it possible for other youth to acquire guns out of self-protection, style, and status concerns. The widespread arming of youth in these disadvantaged neighborhoods made conflicts much more lethal.

This story of the unfolding of the youth violence epidemic is often referred to as the “Blumstein hypothesis” as he was among the first to summarize the existing literature and present hard data supporting key elements of the story. In the period 1985–92, Blumstein (1995) documents three major changes: homicide rates by youth 18 and under doubled, while there was no growth in homicide rates by adults 24 and older; the number of homicides juveniles commit with guns more than doubled, while there was no change in non-gun homicides; and the arrest rate of non-white juveniles on drug charges more than doubled while there was no growth in the drug arrest rate for white juveniles.² Blumstein (1995) suggests that drug sellers in the expanding street-level crack markets actively recruited juveniles in disadvantaged inner-city neighborhoods. Juveniles provided a willing and cheap supply of labor, and were also less vulnerable to harsh punishments imposed by the adult criminal justice system. These armed juveniles were fairly tightly networked with other young people in the neighborhoods and guns “diffused” to other youth who went to the same schools and walked the same streets. Guns, rather than fists or other weapons, were used to settle disputes among youths with deadly results.

Cork (1999) closely examined the linkage between crack market activity and youth gun homicide suggested by Blumstein (1995). In a sample of 53 cities, he finds a sudden increase in youth gun homicide within 3 years of a similar, sharp increase in crack arrests among youth. Across the cities, there was temporal variation in the initiation of crack markets in the cities. However, the common temporal lag across the cities in the sudden appearance of crack markets followed by an upsurge in youth homicide provides compelling evidence on the plausibility of the Blumstein hypothesis (Cork, 1999). City-level studies in Pittsburgh (Cohen and Tita, 1999) and St. Louis (Rosenfeld *et al.*, 1999), using micro-level data on the circumstances of youth homicides, suggest that youth gangs were the dominant factor in

²While Blumstein (1995) notes that there was no growth in homicide rates by adults 24 and older, homicide victimization rates for 25–34 year olds did increase (Cook and Laub, 2002).

the growth of youth homicides. These studies found that crack markets did precede the epidemic of youth homicide and gang members were involved in the street-level drug trade. However, the increase in youth homicide in both Pittsburgh and St. Louis was linked to the emergence of intergang conflicts that spread from gang youth to nongang youth. Other research has suggested that, although crack markets may have sparked the youth violence epidemic, crack was no longer the main driver of youth violence. Rather, the youth violence epidemic had become "decoupled" from crack trafficking as violence became more importantly tied to a complex mix of fear, gangs, guns, and subcultural norms guiding appropriate responses to resolving interpersonal disputes (Kennedy *et al.*, 1996).

While these studies may not agree on the specifics of the trajectory of gangs, crack markets, and increases in youth violence, there seems to be a general consensus that guns diffused from youth who were involved in gangs and/or drug sales to other youth. It remains unclear, however, whether these other armed youth were active offenders, generally non-offending young people, or both. Research suggests that youth who acquire guns for "protection" are significantly more likely to commit guns crimes and street crimes such as robbery when compared with youth who own guns for sport and youth who don't own guns (Bjerregaard and Lizotte, 1995). Gang members are also much more likely to own guns for "protection" than for sporting purposes (Bjerregaard and Lizotte, 1995). To some observers, the important predisposing condition for the youth violence epidemic was the existence of young people either disposed, or sufficiently susceptible, to the use of violence as a means to acquire wealth, status, or resolve disputes (Howell and Hawkins, 1998). For inner-city youths involved in street social networks and street crime, social identity and position in social status hierarchies were tied closely to possessing guns and using guns to defend against status threats (Wilkinson and Fagan, 1996; Fagan and Wilkinson, 1998).

While survey research of both high school students residing in high-violence areas and incarcerated youth has demonstrated that guns have become a central feature of adolescent life for inner-city males (Sheley and Wright, 1995), the available evidence suggests it is likely that the youth violence epidemic was largely concentrated among active offenders rather than non-offending youth. Criminological research has long noted that a relatively high proportion of homicide victims and homicide offenders have a prior criminal record (see, e.g., Wolfgang, 1958). In particular, homicide offenders are likely to commit their murders in the course of long criminal careers consisting primarily of nonviolent crimes but including larger than normal proportions of violent crimes (Swersey and Enloe, 1975; Dawson and Boland, 1993). Homicide victims and offenders are likely to share social

networks and have similar social milieus (Singer, 1981; Reiss and Roth, 1993). This is also true for nonfatal serious violence (Garofalo, 1987; Lauritsen *et al.*, 1991). Recent city-level studies of urban youth homicide problems have documented the same concentration of chronic offenders among youth homicide victims and youth homicide offenders (for a summary, see Braga *et al.*, 2002).

2.2. Characteristics of the Youth Violence Epidemic in Boston

As described earlier, Boston experienced a sudden upswing in youth homicide, measured as victims ages 24 and under, between 1988 and 1989 that peaked in 1990. Relative to the 1990 peak, the yearly number of youth homicides decreased in 1991 but stabilized and remained notably higher through 1995 when compared with the pre-epidemic years of 1984 through 1987 (Fig. 1). As Fig. 2 reveals, Boston gun assault incidents show a slightly different trajectory when compared with youth homicides. Gun assault incidents increased steadily from 796 in 1985 to a peak of 1241 in 1990. Unlike youth homicides, gun assault incidents decreased steadily after the 1990 peak to 802 in 1995. Arrests for youth gun assault offenders and youth gun possession offenders also show a large increase over the course of the 1980s (Fig. 3). However, arrests for youth gun offenders peaked one year later in 1991 and then decreased steadily through 1995. Survey research suggests that Boston high school students were slightly less likely to report

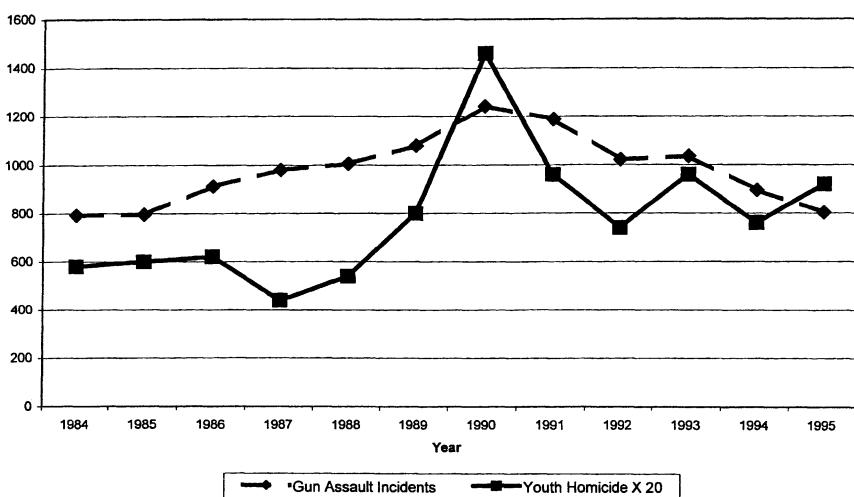


Fig. 2. Boston youth homicide and Boston gun assault incidents, 1984–1995.

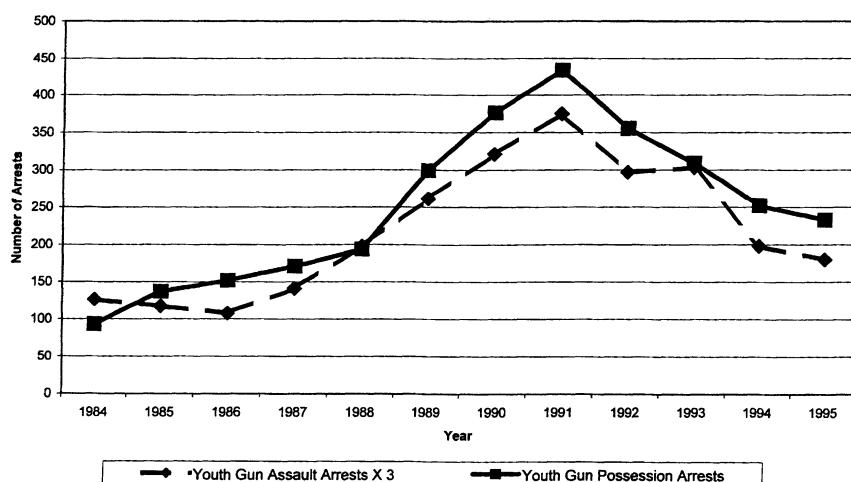


Fig. 3. Boston gun assault and gun possession arrests ages 24 and under, 1984–1995.

carrying a gun between 1993 (10.0%) and 1995 (8.5%) (Kann *et al.*, 1995; 1996). Like most other large cities in the United States, crack appeared in Boston before the significant increases in youth violence. Independent sources suggest crack first appeared in Boston in 1986, about two years before the sudden upswing in youth homicide between 1988 and 1989.³

A close examination of youth gun and knife homicide incidents between 1991 and 1994 revealed that these incidents primarily involved young black males and were largely concentrated within Boston's poorer neighborhoods of Roxbury, Dorchester, and Mattapan (Kennedy *et al.*, 1996). The problem of youth homicide was also concentrated among a small number of chronically offending gang-involved youth. Only about 1,300 gang members—less than 1% of their age group city-wide—in 61 gangs were responsible for at least 60% of all the youth homicide in the city. Chronic disputes, or “beefs,” among gangs appeared to be the most significant driver of gang violence (Braga *et al.*, 1999). A majority of the youth homicide

³The National Institute on Drug Abuse's Community Epidemiology Working Group, which was established to provide ongoing community-level surveillance of drug abuse through the collection and analysis of epidemiological and ethnographic data, suggests that data on crack use and sales in Boston were first reported in 1986 (Kozel, 1997). A close examination of Drug Abuse Warning Network data by Grogger and Willis (2000) also suggests that crack use also appeared in Boston in 1986. In his rigorous statistical analysis of the upswing of youth gun homicides in American cities, Daniel Cork (1999) reports 1988 as the significant change point in the trajectory of juvenile gun homicides in Boston.

victims and youth homicide offenders had prior, and often extensive, criminal histories and involvement with the criminal justice system (Kennedy *et al.*, 1996).

These detailed analyses only examined youth violence after the peak in 1990 and provide little insight on changes in the nature of youth violence over the course of the epidemic. Moreover, the analyses focus on the most extreme form of youth violence—homicide—and offer little direct information on youth carrying guns or engaging in non-fatal gun violence. This paper seeks to unravel whether the criminal profile of youth gun offenders changed over the course of the youth violence epidemic in Boston by analyzing data on the criminal background of youth arrested for gun possession and gun assault offenses. If non-offending youth increasingly participated in gun crimes as the epidemic progressed, arrested gun offenders would be less likely to have extensive criminal histories. If serious youth offenders increasingly participated in gun crimes as the epidemic progressed, arrested gun offenders would be more likely to have extensive criminal histories. No change in the criminal profile of arrested gun offenders would be expected if the same types of offenders committed gun crimes or if serious youth offenders and non-offending youth participated in similar numbers equally over the course of the epidemic.

3. DATA

To assess whether the criminal profiles of youth involved in gun crime in Boston changed over time, criminal history information was collected on gun assault and gun possession offenders, ages 24 and under, arrested between 1984 and 1995. A random sample, stratified by year, of 30 youth gun assault offenders and 30 youth gun possession offenders per year was selected; the final sample had 720 individuals for the 12 year period.⁴ It is important to recognize that these were not panel data. Rather, the data were organized as a set of 12 unique cross-sectional samples of randomly selected youth gun arrestees.

Although police decision-making practices introduce bias to arrest data as a measure of offending activity (Black, 1970), criminologists commonly use arrest data as a proxy for offenders. The demographic characteristics of offenders are usually unknown whereas the demographics of arrestees are

⁴The yearly sampling of youth gun assault arrestees and youth gun possession arrestees was based on the number of unique people arrested per year, not on the total number of arrests for those offenses per year. This was done to ensure that each arrested offender in a given year had the same probability of being included in the sample. Across the 12 years, only 13 individuals appeared twice (3.6%, 26 of 720 cases). Leaving these individuals out of the analyses made no substantive differences in the results described here.

easy to establish (Blumstein, 1995). Studies that have compared victim reports of the demographics of offenders with those of arrestees, for personal crimes such as robbery and aggravated assault, find the two tend to be closely related (Hindelang, 1978). Arrest data were also the only available yearly data that includes the minimum amount of information (name and date of birth) to obtain adult and juvenile criminal history data from the Criminal Offender Record Information (CORI) system maintained by the Massachusetts Criminal History Systems Board. CORI data include information on all arraignments in Massachusetts State and local courts. Thus, any non-Massachusetts offenses or locally committed crimes prosecuted in Federal court would not be captured. Adult and juvenile arraignment histories were generated by running the names and dates of birth of the sampled youth gun offenders through the CORI system. The number of arraignments an individual had before being arrested for the gun crime that led to his/her inclusion in the sample were coded and entered into a computerized database. In other words, if an individual was arrested for a gun assault in September of 1991, only those arraignments on his/her record prior to this date were included in the analysis. The CORI system includes all adult and juvenile arraignments of any individual arraigned in Massachusetts State and local courts since 1981. If an individual was arraigned in 1981, their entire history of adult and juvenile arraignments up to that point in time was entered into the computerized CORI system. As such, these data include all prior arraignments for an individual, not simply arraignments post 1981.⁵

Table I presents the summary statistics of the sample of Boston youth gun offenders. The age of the arrested gun offenders in this sample ranged from 12 to 24, with a mean age of 19.1. Slightly more than 80% of the arrested gun offenders were African-American. Nearly 16% of the arrested gun offenders were White, almost 1% of the arrested gun offenders were Asian, and other races comprised slightly more than 2% of the arrested gun offenders. Nearly 71% of the individuals in the sample had been arraigned at least once before being arrested for a gun possession or assault offense. The mean number of total prior arraignments was 6.4, with one individual having 54 prior arraignments. For the entire sample, the "average" arrested youth gun offender in Boston had nearly two prior violent crime arraignments, nearly two property crime arraignments, and nearly one prior drug offense arraignment.

⁵These insights on the quality of the criminal history data were provided by Professor Jack McDevitt of Northeastern University, who is a member of the Massachusetts Criminal History System Board's research review committee (Personal interview, December 10, 1999).

Table I. Summary Statistics of Sampled Boston Youth Gun Offenders, 1984–1995 ($N = 720$)

<i>Quantitative Variables</i>	Mean	Std. Dev.	Min-Max
Age of arrested gun offender	19.1	2.6	12–24
Total prior criminal arraignments	6.4	8.3	0–54
Total prior drug crime arraignments	0.9	1.9	0–14
Total prior violent crime arraignments	1.8	3.1	0–25
Total prior property crime arraignments	1.7	2.9	0–24
<i>Qualitative Variables</i>	<i>N</i>	%	
African-American	582	80.8	
White	115	15.9	
Asian	6	0.8	
Other	17	2.4	
Male	690	95.8	
Female	30	4.2	
Arrested for gun assault offense	360	50.0	
Arrested for gun possession offense	360	50.0	
At least one prior arraignment	509	70.7	

4. ANALYSIS

4.1. Simple Trends in the Criminal Profile of Boston Arrested Youth Gun Offenders

Between 1984 and 1995, the percentage of arrested Boston youth gun offenders with a criminal record and the average number of prior arraignments per arrested youth gun offender increased. Figure 4 presents the yearly percentage of Boston arrested youth gun offenders that had at least one prior juvenile and/or adult arraignment. In 1984, only 53.3% of arrested youth gun offenders had a prior criminal record. This percentage increased steadily through 1995, when 83.3% of arrested youth gun offenders had a prior criminal record. Figure 4 also reveals a similar linear increase in the yearly percentage of Boston arrested youth gun offenders that had at least one prior juvenile and/or adult drug arraignment. In contrast to the assertion of the “Blumstein hypothesis” that youth gun violence diffused away from drug markets, the percentage of Boston arrested youth gun offenders involved in drug crimes increased over the course of the gun violence epidemic. Figure 5 presents the yearly mean number of prior adult and juvenile arraignments for Boston arrested youth gun offenders. The mean number of prior arraignments increased linearly from 3.75 arraignments in 1984 to 9.28 arraignments in 1995.

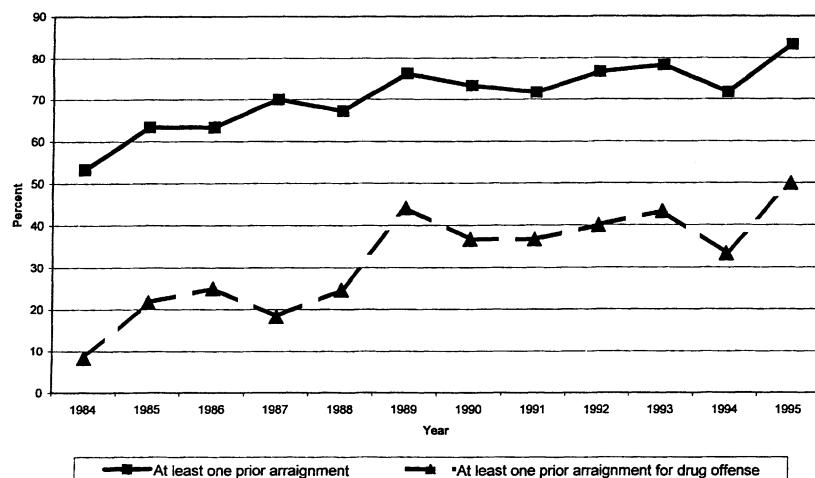


Fig. 4. Percent of arrested youth gun offenders with at least one prior arraignment.

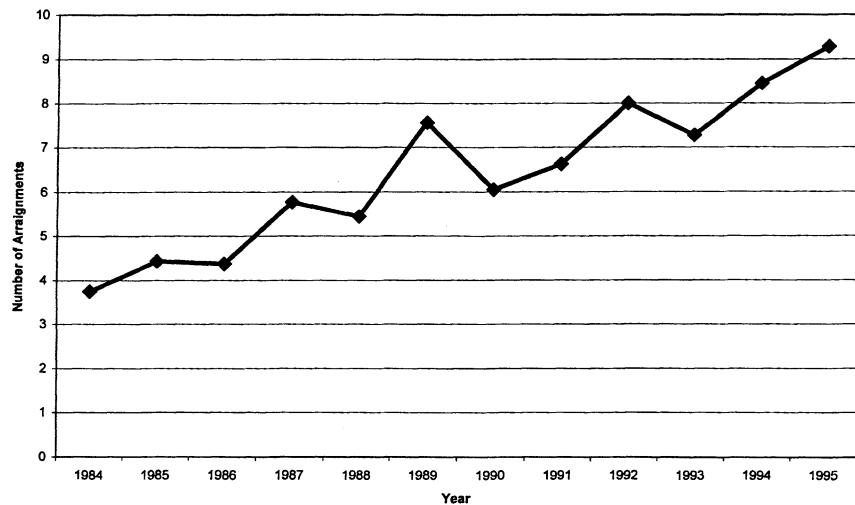


Fig. 5. Mean number of criminal arraignments prior to arrest for gun offense.

4.2. The Negative Binomial Regression Model

Prior adult and juvenile arraignments are distributed in the form of rare event counts. There are well-documented problems associated with treating event count variables, which are discrete, as continuous realizations of a normal data generating process (see King, 1989, p. 126). As such, methods

such as standard mean difference tests and ordinary least squares regression that assume population normality of the dependent variable should not be used to analyze count data (see Gardner *et al.*, 1995, pp. 393–394). Rather, Poisson regression is generally used to estimate models of the event counts (Long, 1997). The Poisson regression model has the defining characteristic that the conditional mean of the outcome is equal to the conditional variance. However, in practice, the conditional variance often exceeds the conditional mean (Long, 1997). When a sample count distribution exhibits this “overdispersion,” it is unlikely that a Poisson process generated it. Assuming a Poisson process, when the true process generates overdispersed data, results in the same coefficient estimates but underestimates coefficient variances. This results in spuriously large test statistics on the hypothesis that the true coefficient is equal to zero in the population (Gardner *et al.*, 1995, p. 399). As will be demonstrated in the formal analysis, the distributions of counts of prior arraignments of arrested Boston youth gun offenders were overdispersed. When count data are overdispersed, it is appropriate to use the negative binomial generalization of the Poisson regression model. As Long (1997) describes, the negative binomial regression model is an extension of the Poisson regression model that allows the conditional variance of the dependent variable to exceed the conditional mean through the estimation of a dispersion parameter.

4.3. Negative Binomial Regression Analysis of the Criminal Record of Boston Arrested Youth Gun Offenders

Changes in the criminal profile of Boston youth offenders arrested for gun crimes were examined by estimating four negative binomial regression models with the following dependent variables: the total number of prior arraignments, the number of prior arraignments for property crimes, the number of prior arraignments for drug crimes, and the number of prior arraignments for violent crimes. The independent variables were age of the offender, sex of the offender, race of the offender, type of gun arrest offense, and year of arrest. The demographic variables were included in the regression models to safeguard against any changes in criminal profile in a particular year that may have been an artifact of sampling error rather than a substantive change (e.g., by chance, sampling may have selected a higher number of females in a given year). Excluding the demographic variables from the models do not substantively change the results. Any small discrepancies between the two model specifications are noted below in the discussion of the results of the fully-specified model.

Age was entered into the equation as a continuous variable. Sex, race, gun arrest offense, and year of arrest were coded as dummy variables.

Following the conventions of constructing dummy variables, the most frequent category for each variable was selected as the reference category. As such, the sex variable was coded '1' for females; the race variable was coded '1' for Whites, Asians, and other races; the gun arrest offense variable was coded as '1' for offenders arrested for gun assault. Gun offenders arrested in 1995 were coded as '1' in the Year 1995 variable and coded as '0' on all other year variables. Gun offenders arrested in 1984 and 1985 served as the reference category for the other year dummy variables. These years serve as good pre-epidemic reference points as the numbers of youth homicide incidents in Boston were stable in 1984 and 1985 (Fig. 1). For convenience, the years 1989 and 1990 will be referred to as the "epidemic years" and the years 1991 through 1995 will be referred to as the "post-epidemic years."

Inserting the total number of prior arraignments as the dependent variable, the basic model was as follows:

$$\text{Count of total prior arraignments} = \text{Alpha} + \text{Age} + \text{Race} + \text{Sex} + \text{Gun Arrest Offense} + \text{Year 1986} + \text{Year 1987} + \text{Year 1988} + \text{Year 1989} + \text{Year 1990} + \text{Year 1991} + \text{Year 1992} + \text{Year 1993} + \text{Year 1994} + \text{Year 1995} + \text{Error}$$

The parameters for the independent variables were expressed as incidence rate ratios (i.e., exponentiated coefficients). Incidence rate ratios are interpreted as the rate at which things occur; for example, an incidence rate ratio of 0.40 on the sex dummy variable would suggest that, controlling for other independent variables, women were associated with 60% fewer prior arraignments relative to men. To ensure that the coefficient variances were robust to violations of the homoskedastic errors assumption of linear regression models, Huber/White/sandwich robust variance estimators were used. Following social science convention, the two-tailed 0.05 level of significance was selected as the benchmark to reject the null hypothesis of "no difference."

Table II presents the results of the negative binomial regression models. For the four models, the alpha coefficient is statistically significant. This confirms that the data were significantly overdispersed and, as such, were distributed as a negative binomial process rather than a Poisson process.⁶

⁶Table II reports the z-scores for the test that alpha = 0. Another method to determine whether the data are distributed negative binomial is to calculate a likelihood ratio test of whether adding alpha to the count data model significantly improves the fit of the Poisson model to the data. Stata 7.0 calculates this likelihood ratio test when a negative binomial model is run with standard variance estimators (StataCorp, 2001, p. 387). Since the reported models were run with robust estimators that assume the errors may have unknown correlation, this likelihood ratio test, which assumes independence, could not be run. However, when the models were run with standard variance estimators, the likelihood ratio tests that alpha = 0 were statistically significant. The chi-square results were: 3759.77 for total arraignments, 492.33 for drug crime arraignments, 1094.53 for property crime arraignments, and 1081.81 for violent crime arraignments. These results assert that the probability that these data would be observed conditional on the process being Poisson is zero.

Table II. Results of Negative Binomial Regression Models ($N = 720$)

Variable	Total crime	Property crime	Drug crime	Violent crime
Age	1.14 (6.96)*	1.11 (4.27)*	1.18 (5.57)*	1.10 (3.91)*
Race	1.13 (0.91)	1.52 (2.46)*	0.47 (-3.07)*	0.77 (-1.33)
Sex	0.50 (-2.56)*	0.85 (-0.51)	0.21 (-2.78)*	0.52 (-2.00)*
Gun arrest offense	1.28 (2.74)*	1.16 (1.21)	1.44 (2.49)*	1.64 (3.94)*
Year 1986	1.23 (0.88)	1.14 (0.42)	1.88 (1.69)	0.78 (-0.76)
Year 1987	1.71 (2.59)*	1.63 (1.71)	2.16 (1.93)	1.62 (1.69)
Year 1988	1.48 (1.64)	1.28 (0.73)	3.15 (2.72)*	1.48 (1.36)
Year 1989	2.15 (4.11)*	1.91 (2.72)*	6.00 (5.32)*	1.57 (1.77)
Year 1990	1.82 (2.97)*	1.39 (1.34)	6.35 (5.18)*	1.84 (1.98)*
Year 1991	2.04 (3.55)*	1.06 (0.23)	5.71 (4.84)*	1.82 (2.26)*
Year 1992	2.25 (4.21)*	1.53 (1.68)	6.01 (5.16)*	1.97 (2.45)*
Year 1993	2.22 (4.19)*	1.18 (0.64)	9.44 (6.66)*	1.88 (2.32)*
Year 1994	2.49 (4.55)*	1.48 (1.61)	4.89 (4.44)*	2.81 (3.53)*
Year 1995	2.74 (5.22)*	1.51 (1.79)	9.75 (6.80)*	2.55 (2.95)*
Ln alpha	0.562 (8.41)*	0.891 (10.45)*	0.934 (8.42)*	0.821 (9.31)*
Alpha	1.754 (14.98)*	2.437 (11.73)*	2.543 (9.02)*	2.272 (11.35)*
Log likelihood	-2012.95	-1194.37	-804.29	-1205.49
Pseudo R ²	0.0169	0.0120	0.0635	0.0232
Wald chi-square	91.71*	39.60*	117.57*	57.94*

* $P < 0.05$.

Note: Binomial regression model coefficients were expressed as Incidence Rate Ratios with respective Z-scores in parentheses. Gun offenders arrested in 1984 and 1985 were included in the reference category. For all four models, the Wald chi-square statistic was distributed with 14 degrees of freedom.

For all models, controlling for other independent variables, as the age of the arrested youth gun offender increased, the count of prior arraignments significantly increased. While there were no significant differences in the total number of prior arraignments and prior violent crime arraignments, holding other variables constant, African-American youth gun offenders had significantly higher counts of prior drug offense arraignments and significantly lower counts of prior property crime arraignments relative to youth gun offenders who were White, Asian, and belonged to other racial groups. Controlling for other variables, female youth gun offenders had significantly lower counts of total prior arraignments, prior drug crime arraignments, and prior violent crime arraignments relative male youth gun offenders. Individuals arrested for gun assault offenses had significantly higher counts of total prior arraignments, prior drug crime arraignments, and violent crime arraignments relative to individuals arrested for gun possession offenses, holding other variables constant.

The negative binomial regression models revealed significant changes in the criminal profile of gun offenders arrested in Boston between 1984 and

1995. Youth gun offenders arrested during the epidemic and post-epidemic years had larger numbers of prior arraignments when compared with youth gun offenders arrested in the pre-epidemic years. Relative to youth gun offenders arrested in 1984 and 1985, holding other variables constant, the total number of prior arraignments significantly increased in 1987, were not significantly different in 1988, significantly increased in 1989, and remained significantly higher through 1995. The total count of prior arraignments for arrested gun offenders had increased by 82% in 1990 and by 174% in 1995, relative to the total count of prior arraignments for gun offenders arrested in 1984 and 1985. The period of sustained higher counts of prior arraignments for youth gun offenders arrested during the epidemic and post-peak epidemic years was also significantly different from the counts of prior arraignments for youth gun offenders arrested in prior years. A likelihood ratio test revealed that the coefficients for the year 1989 through year 1995 dummy variables were jointly significantly different from zero ($\chi^2 = 34.51$, 7 degrees of freedom, $P < 0.05$).

These results were primarily driven by increases in prior arraignments for drug and violent offenses. With the exception of a significant increase in 1989, controlling for other variables, the counts of prior property crimes of arrested youth gun offenders were not significantly different in later years relative to 1984 and 1985.⁷ It is important to note that the lack of significant changes in the counts of prior property offenses over time provides some additional confidence that the observed changes in drug and violent prior offenses was not an artifact of some change in the overall quality of the criminal history data over time. Relative to youth gun offenders arrested in 1984 and 1985, holding other variables constant, the total number of prior arraignments for drug offenses significantly increased in 1988 and remained significantly higher through 1995. The count of prior drug arraignments for arrested gun offenders had increased by a factor of 6 in 1990 and by nearly ten-fold in 1995, relative to the count of prior drug arraignments for gun offenders arrested in 1984 and 1985. A likelihood ratio test revealed that the coefficients for the year 1988 through year 1995 dummy variables were jointly significantly different from zero ($\chi^2 = 58.07$, 8 degrees of freedom, $P < 0.05$). The significant change in the count of prior violent offenses for youth gun offenders arrested in Boston started two years later. Relative to youth gun offenders arrested in 1984 and 1985, holding other variables constant, the count of prior arraignments for violent offenses significantly increased in 1990, the height of the youth homicide epidemic,

⁷The count of prior property crimes of arrested gun offenders in 1989 was not significantly different from 1984 and 1985 in the binomial regression model without the demographic control variables.

and remained significantly higher through the post-peak epidemic years.⁸ The count of prior violent arraignments for arrested gun offenders had increased by 84% in 1990 and more than doubled by 1995, relative to the count of prior arraignments for gun offenders arrested in 1984 and 1985. A likelihood ratio test revealed that the coefficients for the year 1990 through year 1995 dummy variables were jointly significantly different from zero ($\chi^2 = 14.51$, 6 degrees of freedom, $P < 0.05$).

4.4. Changes in the Nature of Youth Gun Assault Incidents

The simple trend analyses and the more rigorous negative binomial regression models suggest that youth gun offending in Boston was concentrated among more serious youth gun offenders over the course of the youth violence epidemic. However, these results provide little insight on whether the nature of youth gun assaults in Boston changed over the course of the epidemic. To unravel whether there were noteworthy changes in the nature of these violent events, data on youth gun assault incidents, for youth ages 24 and under, were closely examined for three years that represented distinct periods in Boston's youth homicide epidemic—1987, 1990, and 1995. The analyses were limited to one high-risk police district due to limitations of the Boston Police Department (BPD) incident data. The computerized BPD gun assault incident data do not capture the age of the victim. Information on the age of the gun assault victim was only available from hard copies of gun assault incident reports. Since the collection and coding of this information was a time consuming task, these data were collected for District B-2, which covers most of Boston's Roxbury neighborhood, has a very dense concentration of gangs, and experienced a third of Boston's youth homicide incidents between 1991 and 1995 (Kennedy *et al.*, 1996).

Table III presents the results of an analysis of B-2 youth gun assault incidents. Handguns were used in about 90% of B-2 youth gun assault incidents in 1987 and 1990, and increased slightly to 96% of B-2 youth gun assault incidents in 1995. Youth gun assaults in B-2 were more likely to occur in a public fashion after 1987. In 1987, slightly more than 70% of B-2 youth gun assault incidents occurred outside; during 1990 and 1995, youth gun assault incidents occurring outside increased to 85%. Similarly, B-2 youth gun assaults were more likely to result in a wound after 1987. Only

⁸In the binomial regression model without the demographic control variables, the count of prior violent crimes for arrested gun offenders significantly increased, relative to 1984 and 1985, beginning one year later in 1991. The alternative specification revealed the count of prior violent arraignments for arrested gun offenders had increased by 72% in 1990 relative to 1984 and 1985, but was not statistically significant at the 0.05 level ($P = 0.082$).

Table III. District B-2 Gun Assault Incidents, Victims Ages 24 and Under

	1987 (N = 153)	1990 (N = 244)	1995 (N = 155)
Type of Firearm			
Handgun	91%	90%	96%
Shotgun	3%	6%	1%
Rifle	1%	3%	0%
Unknown	5%	1%	3%
Location			
Inside	18%	12%	10%
Outside	71%	85%	85%
Not clear	11%	3%	5%
Wound Inflicted	40%	56%	56%
Number of Wounds	(N = 61)	(N = 138)	(N = 92)
One	72%	72%	62%
Two or more	28%	28%	38%
CASE FATALITY RATE = [Number of B-2 youth gun homicides/Number of B-2 youth gun assault incidents] * 100			
Number of B-2 youth gun homicides	5	14	16
Number of B-2 youth gun assaults	153	244	155
Case fatality rate	3.3	5.7	10.3

40% of B-2 youth gun assaults resulted in a wound in 1987; in 1990 and 1995, 56% of B-2 youth gun assaults resulted in wounds. In those instances where a youth was wounded, the number of multiple gunshot wounds increased from 28% in 1987 and 1990 to 38% in 1995. Finally, case fatality rates were calculated to estimate the percentage of B-2 youth gun assaults that were fatal in each of the three years. These data suggest an increase in the intent to kill over time (Table III). In 1987, 3.3% (5 of 153) of youth gun assaults resulted in a fatality; in 1990, 5.7% (14 of 244) of youth gun assaults resulted in a fatality; by 1995, 10.3% (16 of 155) of youth gun assaults resulted in a fatality. Although the absolute number of B-2 youth gun assaults in 1995 was essentially the same as 1987, the likelihood of a youth gun assault resulting in a fatality in B-2 tripled.⁹

These analyses suggest intensification in B-2 youth gun violence between 1987 and 1995. Post 1990, B-2 youth gun assault incidents were increasingly committed in a public fashion, more likely to result in a wound, more likely to result in multiple wounds, and more likely to result in death.

⁹A similar analysis of the rapid increase in homicide in Harlem between 1968 and 1974 found that the increase in killing was the result of an increase in the case-fatality rate of gun assaults rather than an increase in the number of gun assaults (Swersey and Enloe, 1975).

These results could be influenced by changes in the technology of the handguns used by youth in B-2. Unfortunately, the micro-level data to examine these changes were not available. However, as Fig. 6 reveals, there was a gradual shift from six-shot revolvers to higher capacity semiautomatic pistols among all crime handguns recovered by the BPD between 1981 and 1995.¹⁰ Table IV reveals that the caliber of these recovered handguns also changed during this time period. Two themes were evident: the yearly percentage of .22 and .38 caliber handguns decreased over this time period while the yearly percentage of .380 and 9 mm caliber handguns increased, particularly in 1995. Between 1991 and 1995, previous research revealed that firearms associated with youth, especially with gang youth, tended to be newer semiautomatic pistols (Kennedy *et al.*, 1996). Unfortunately, without micro-level data on the guns used in the B-2 incidents, the possible effects of these technological changes on the observed results of our youth gun assault incident analysis remain unclear. Since few gun assault incidents involve large numbers of shots fired, the larger capacity of semiautomatic pistols relative to revolvers may not be relevant (Kleck, 1997). The decrease in low-powered .22 caliber handguns may suggest an increase in the overall lethality of crime guns recovered in Boston. However, possible changes in lethality associated with shifts among medium-powered .38, .380, and 9 mm handguns are less significant.¹¹

5. CONCLUSION

Boston's youth violence epidemic, as measured as a homicide problem, started in 1988, was preceded by the arrival of crack in 1986, and was contained mostly within Boston's young black male population residing in a few disadvantaged neighborhoods. Gangs and criminally active youth were at the core of the Boston's violence problem. The negative binomial regression models reveal that the criminal profile of youth gun offenders significantly changed as the youth violence epidemic progressed. Beginning in 1988, arrested youth gun offenders were significantly more likely to have higher counts of prior drug arraignments and, beginning in 1990, were significantly more likely to have higher counts of prior violent offenses. These results suggest that the youth violence epidemic was concentrated

¹⁰These data on handguns recovered in crime by the BPD were generated through an analysis of the comprehensive records kept by the BPD's Ballistics Unit. While these data provide consistent information on the basic features of recovered handguns, the data do not consistently capture the location of the recovery or the demographics of the offender associated with the recovery.

¹¹For an informed discussion of the lethality of different firearm calibers, see Karlson and Hargarten (1997).

Table IV. Yearly Percentages of Top Calibers of Handguns Recovered in Boston, 1981–1995

Year	Total handguns recovered	.22	.25	.32	.357	.38	.380	9 mm
1981	650	20.6%	12.8%	12.2%	5.4%	33.2%	3.4%	4.2%
1982	697	21.3%	10.2%	12.2%	6.3%	33.7%	5.6%	3.4%
1983	568	23.2%	11.1%	13.9%	6.9%	32.9%	2.8%	2.5%
1984	597	20.1%	14.9%	11.6%	7.0%	31.8%	4.5%	2.5%
1985	565	18.8%	13.8%	12.9%	6.5%	32.9%	5.1%	3.7%
1986	631	19.0%	16.0%	15.1%	6.3%	28.8%	3.8%	3.0%
1987	459	23.9%	16.6%	10.5%	6.1%	27.6%	3.7%	6.3%
1988	556	17.2%	17.2%	9.5%	7.4%	30.0%	5.8%	6.1%
1989	595	16.8%	14.1%	12.7%	6.9%	27.8%	5.5%	11.4%
1990	805	16.0%	14.2%	10.1%	7.5%	22.8%	9.6%	12.9%
1991	829	14.5%	17.5%	11.0%	6.9%	17.0%	11.8%	14.5%
1992	766	14.2%	16.1%	10.6%	7.6%	18.8%	10.8%	14.9%
1993	613	15.6%	16.0%	10.1%	5.4%	19.2%	13.2%	14.3%
1994	622	12.2%	14.6%	7.9%	6.1%	18.2%	13.8%	19.6%
1995	583	9.1%	13.7%	7.9%	5.8%	11.7%	17.0%	25.6%

among more serious youth gun offenders rather than non-offending youth. The higher counts of prior drug convictions underscore the continuing importance of involvement in the street level drug trade as a risk factor for youth gun offending.

The results of the simple trend analyses and negative binomial regression models could, of course, be influenced by enforcement bias introduced by a deliberate focus by Boston police on street drug markets and perceived gang areas. It is possible, in theory, that there was a volume of youth carrying guns in Boston that did not come to the attention of the police, for instance guns carried by otherwise non-offending youth that armed themselves out of fear. If such youth actually used their guns to settle interpersonal disputes, however, they stood at least some likelihood of coming to police attention as gun assaulters. If non-offending youth contributed meaningfully to the gunplay in the youth violence epidemic, their likelihood of coming to police attention as gun carriers would have increased over time as the police adjusted their enforcement response beyond street drug markets and gang turf areas. While guns may have been possessed and carried by non-criminal Boston youth, these analyses suggest they did not contribute much to the epidemic of youth violence. The preponderance of youth homicide victims and youth homicide offenders in Boston involved gang-involved chronic offenders (Kennedy *et al.*, 1996) and the non-lethal gun crime that comes to the attention of the Boston police was similarly concentrated among serious youth offenders.

The further analyses of gun assault data in District B-2 suggest that the nature of violent gun events also changed over the course of the youth violence epidemic. Boston gun assault incidents and arrests for youth gun crimes declined notably after their respective 1990 and 1991 peaks. Youth homicides, however, declined from the 1990 peak to 1991 and remained relatively high through 1995. In District B-2, there is evidence that gun violence intensified during the 1990 through 1995 time period as youth gun assault incidents were increasingly public in fashion and lethal. Coupled with the results from the regression models, these findings paint a picture of Boston youth gun violence that was highly concentrated among serious youth offenders who carried high capacity semiautomatic pistols and used their guns in an increasingly deadly way. In Boston, the youth violence epidemic was an intense "flood in a canyon" rather than a diffusion of guns away from the street drug trade, gangs, and criminally active youth.

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